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GEA-439B\*

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Brooklyn Edison Building Illuminated by Floodlighting Projectors

## A Short Cut to the Solution of Floodlighting Problems

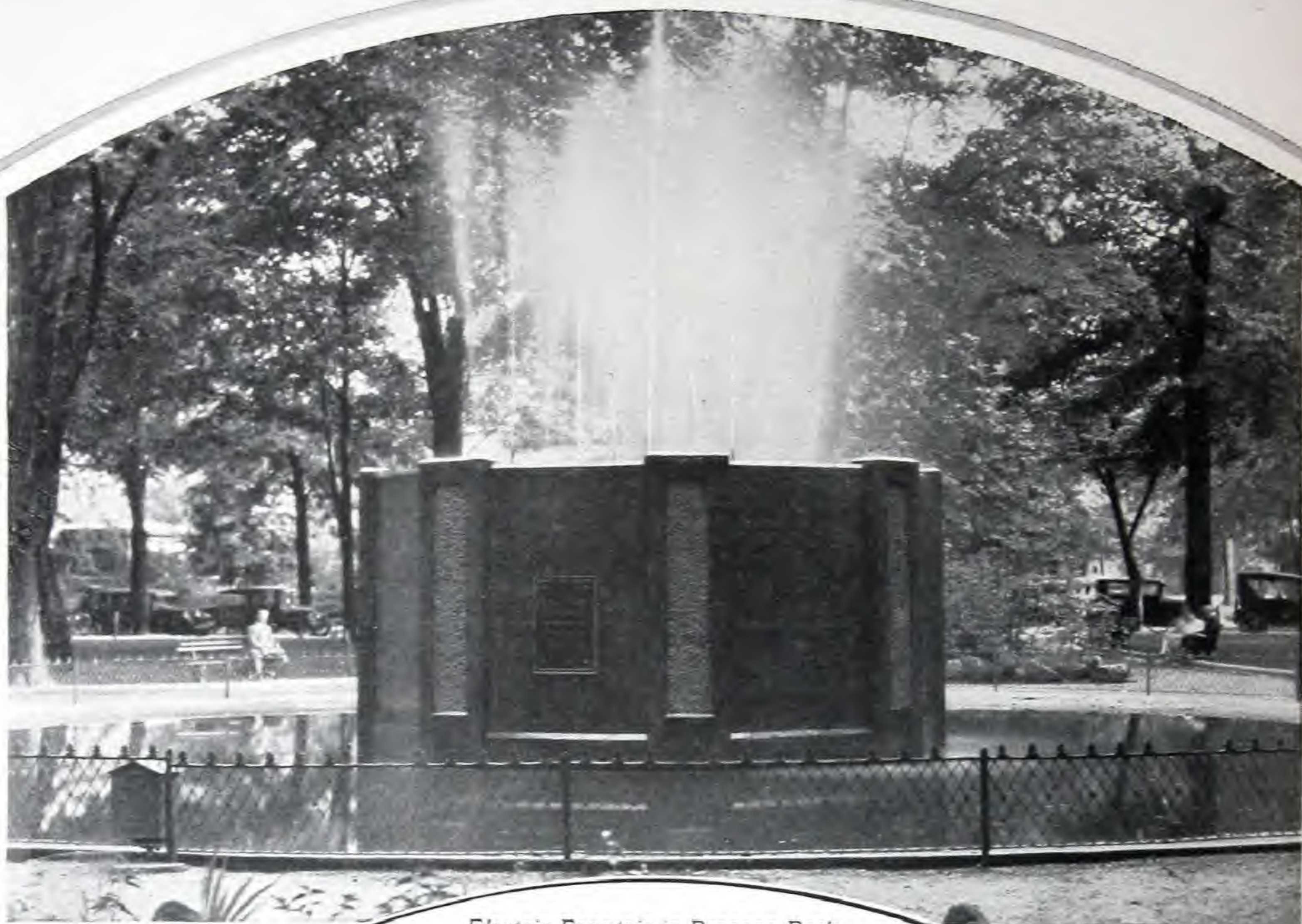


\*Supersedes GEA-439A

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*Electric Fountain in Bronson Park,  
Kalamazoo, Michigan*

## When People "Point with Pride"

He is a poor citizen who doesn't boost his home town—and boosters generally climax their praise with some conspicuously beautiful feature.

Kalamazoo "points with pride" to its new electric fountain in Bronson Park—to the interplay of brilliant colors on its shifting spouts of water—to the crowds of citizens and visitors who enjoy the nightly spectacle—to the hearty approval with which it has been accepted as a credit to the city and to the administration.

Floodlighting specialists of the General Electric Company who made the installation adapted an existing water supply and an old basin to the requirements of electric operation and thus saved a considerable item of expense. With thirty lighting units in five colors and a series of water combinations, fifty different effects are automatically produced.

Electric fountains bring new distinction to a city and public approbation to the responsible municipal authorities.



General Electric specialists are ready at all times to consult with civic representatives and to supply complete electrical and mechanical fountain equipment. Address the nearest G-E office.



# A Short Cut to the Solution of Floodlighting Problems

By H. E. BUTLER

ILLUMINATING ENGINEERING LABORATORY, GENERAL ELECTRIC COMPANY

The inception of floodlighting dates back to the year 1915, when the Panama-Pacific Exposition made the first notable use of it. The method of lighting exteriors in vogue up to that time consisted mainly in hanging strings of incandescent or arc lamps across the front of the building to be lighted, or on neighboring poles, trees, etc., which was an arrangement unsightly in appearance as well as in the production of a general glare which detracted from, rather than added to, the natural beauty of the structure.

Floodlighting, however, met these objections by concealing the sources of light and bringing the facade of the building into brilliant relief against the darkness, accentuating the details of construction and adding a new beauty to them. Architects and engineers promptly approved this innovation in the art of illumination because it gave the building a real rather than an artificial appearance at night, and also did not detract from its looks in the daytime. With the impetus given to it by the Panama-Pacific Exposition, floodlighting at once became a special department of illumination practice, and the years that have passed since then have seen constant improvements in equipment, as well as a rapidly widening field for its application. To-day, floodlighting is looked upon as one of the important uses of the electric light.

This method of illumination is recognized as a successful form of advertising and a stimulus to business. The rapidly increasing number of such installations throughout the world proves that it has become a necessity, and indicates that a still more advantageous and extensive use of it awaits only an increased familiarity with methods for the solution of such problems and the selection of suitable equipment.

Although the field of this type of lighting has been greatly extended during the past

few years, the future is still more promising. Among the many prominent applications coming into favor to-day, are those for scenic displays, aviation landing fields, evening football and baseball games, electric fountain illumination, building and construction at night, freight yards, grain elevators, quarries, shipyards, docks, billboards, signs, advertising banners, etc. Typical examples such as are given in Fig. 1, 2, 3, and 4 illustrate how well floodlighting units can be used for a wide variety of purposes.

## Installation Factors

The directional distribution of a floodlight causes sharp shadows that make it unsuitable for general interior illumination. Commercial floodlights with clear doors have an approximate spread of 11 to 50 deg., so that the type to be used will depend upon local conditions.

There are three important factors to be considered before it can be definitely determined what type of unit will best meet the conditions encountered:

- (1) The working distance; i.e., the distance from the projectors to the surface to be illuminated.

- (2) The surrounding characteristics; i.e., whether the area to be lighted is located along a "white way," a residential section, a park, or a place where there is no other light source.

- (3) The color of the object to be illuminated; i.e., whether the surface is dark, medium, or light.

The first of these determines the most suitable type of projector. The second and third determine the foot-candle intensity required. When selecting floodlighting projectors, particular consideration must be given to the area that is to be illuminated, to the beam spread, and to the distance the beam is to be projected. Naturally the use of a wide-beam





Fig. 2. Railroad Freight Yard with Floodlighting

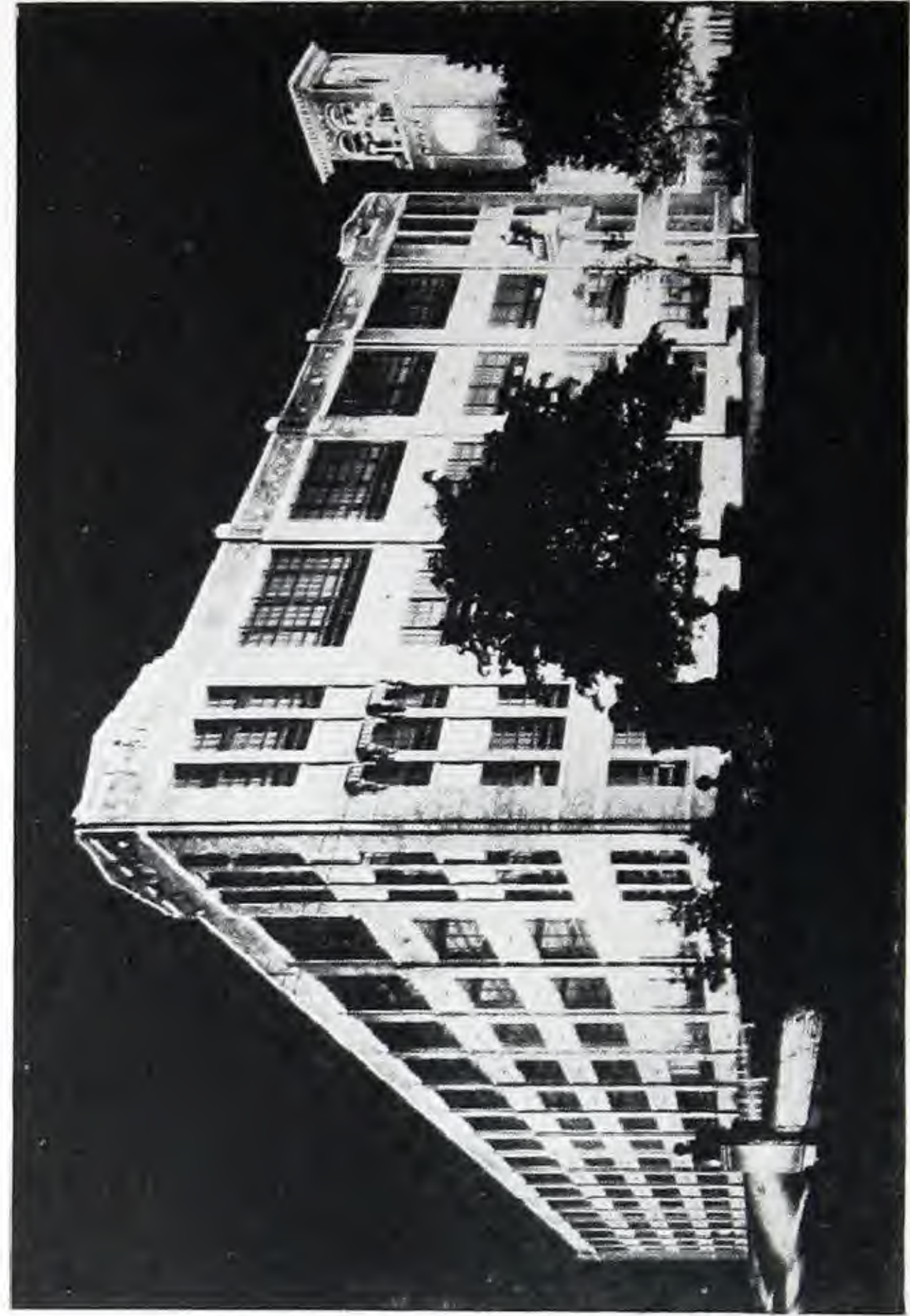


Fig. 4. Industrial Building with Facade Completely Illuminated

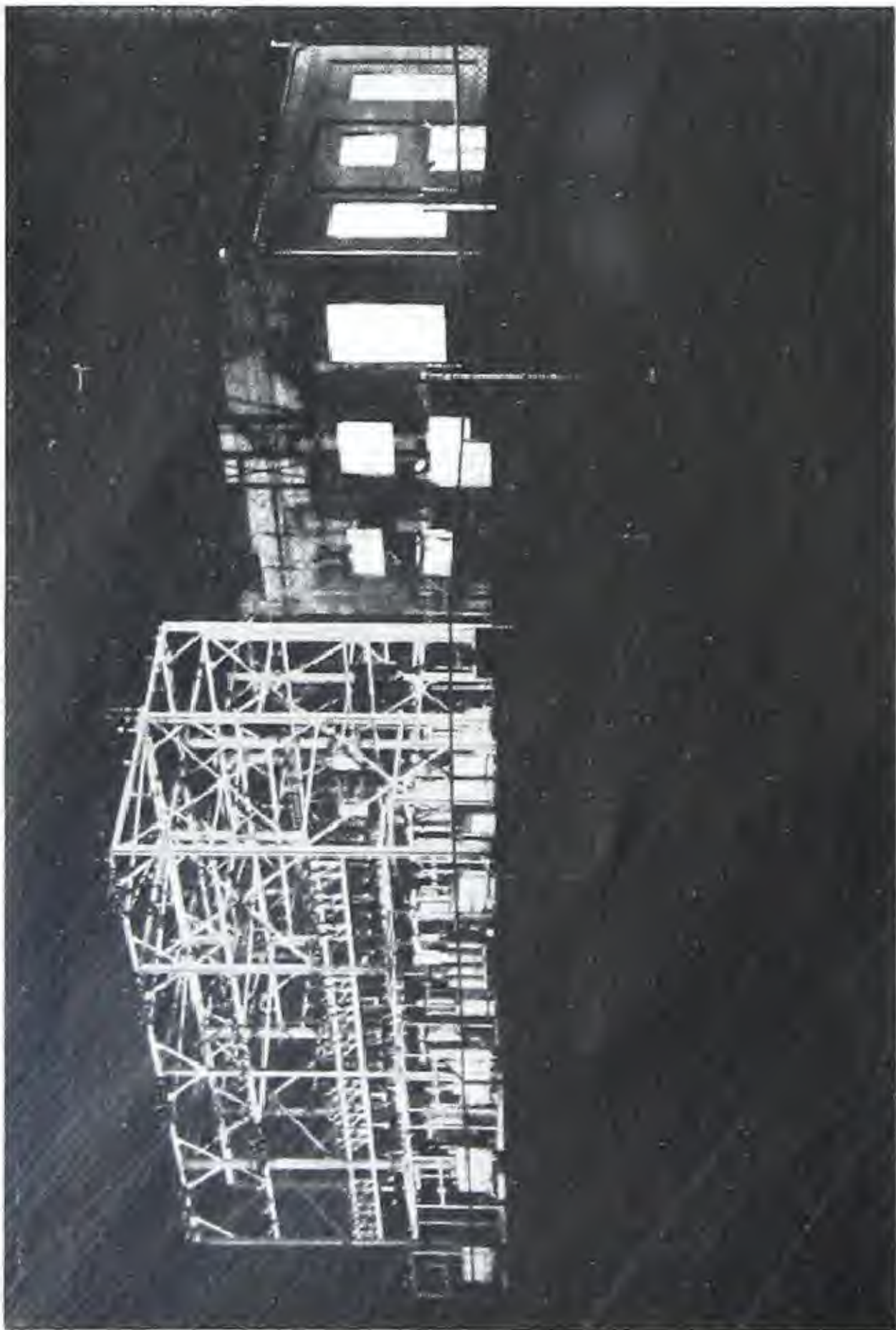


Fig. 1. Outdoor Electric Switching Yard by Night



Fig. 3. Playing Golf After Dark



unit for a small area or a narrow-beam unit for a large area will not give satisfactory results.

For the many cases where the angle between the beam axis and the surface to be illuminated lies between 70 and 90 deg., the data given in Table I will determine the most suitable type of floodlight and the number of units necessary.

When computing intensity values, note may be made of the fact that full moonlight is approximately 1/40 foot-candle. Table I gives the following data: the type of floodlight units, the size of lamps used in each type of unit, the photograph of the unit, the

beam spread, the working distance for each type of projector, and curves indicating the number of units required to illuminate areas at various intensities. Table II lists the intensities that should be used for white-ways, residential sections, and parks when the surfaces are dark, medium, or light.

### Examples

To furnish an example of the application of the data given in Table I, a problem involving the lighting of an area 1500 sq. ft. will be computed. The conditions require the units to be installed 130 ft. from the surface to be illuminated. The color of the building

TABLE I

FORM L-1 500W FLOODLIGHTING LAMP METAL REFLECTOR			FORM L-9 500W FLOODLIGHTING LAMP GLASS REFLECTOR			FORM L-20 AND L-11 200W-250W FLD. Ltg. LAMP GLASS REFLECTOR			** FORM L-3 500W FLOODLIGHTING LAMP GLASS REFLECTOR			FORM L-15 1000W STD MAZDA LAMP GLASS REFLECTOR			FORM L-22 AND L-24 1000W STD MAZDA LAMP GLASS REFLECTOR																																																																																																																																																																																																																																																																																																																																																																					
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\*\* The manufacture of L-3 projectors has been discontinued.

NOTE.—In using Table I the angle between axis of beam and surface lighted must not be less than 70 degrees.



### One-way Projection of Light

#### Advantages:

Economical to install and maintain

No glare

#### Disadvantages:

No silhouette effect

Non-uniform distribution of light

Inefficient in smoke or fog

### Distributed System

#### Light Projected in the Direction of Traffic

#### Advantages:

Uniform distribution of light

Effective in smoke or fog

No glare

#### Disadvantages:

Higher installation and maintenance cost

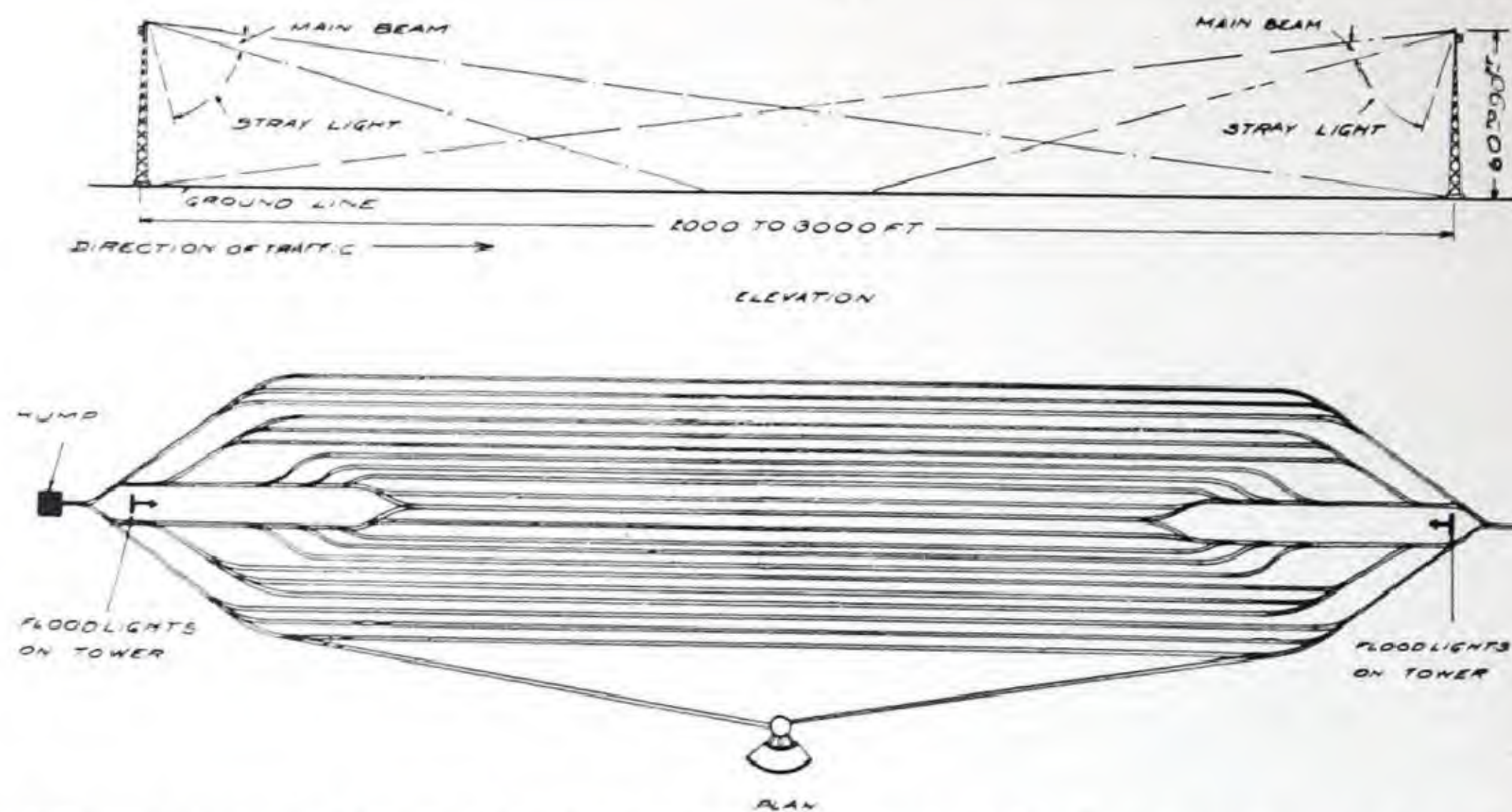


Fig. 8. Schematic Diagram of the Selkirk Switching Yards of the New York Central Railroad Showing Method of Floodlight Distribution

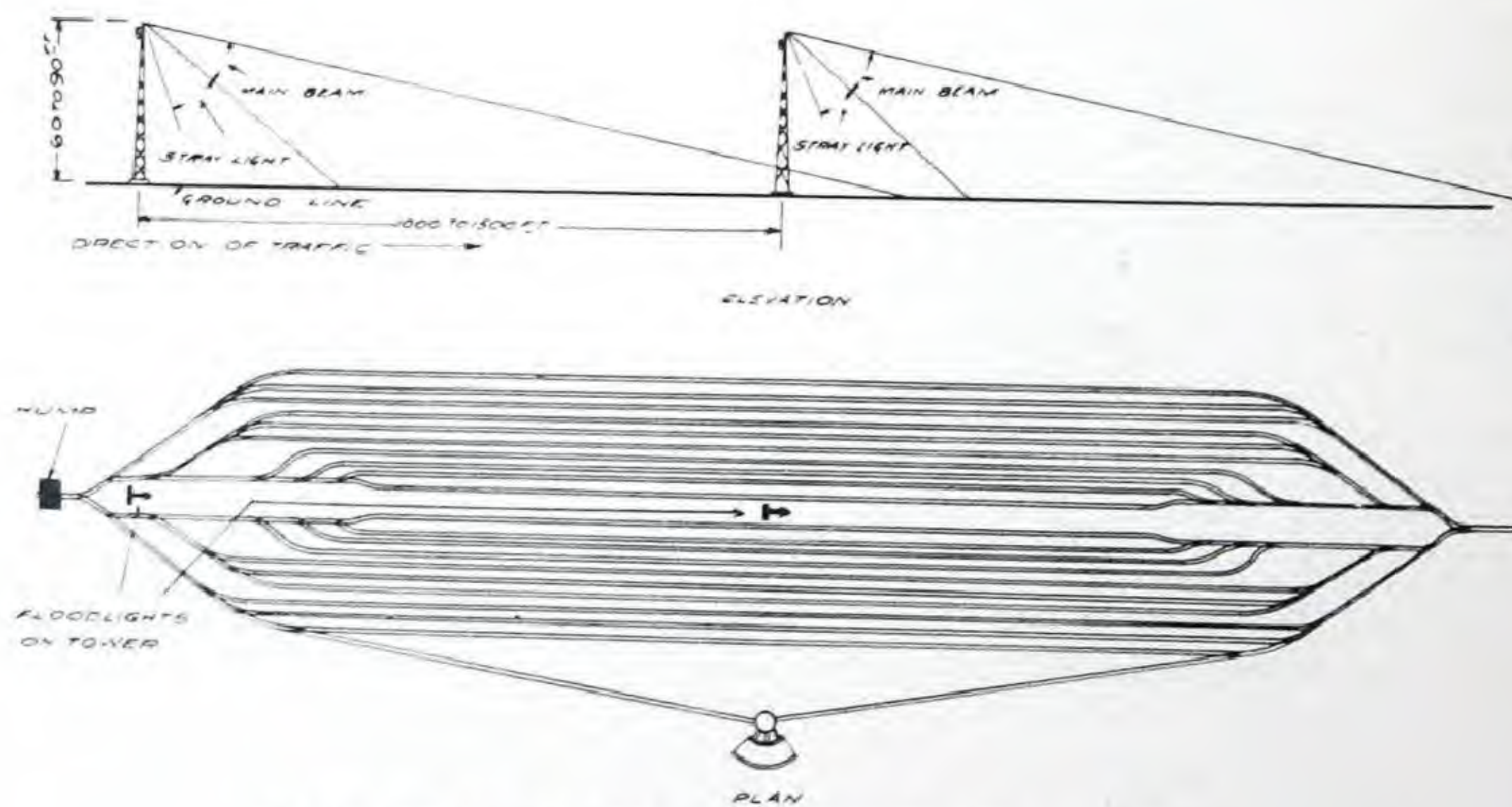


Fig. 9. An Alternative Arrangement to That Shown in Fig. 8



Fig. 10. Low Power Floodlighting with Close Spacing to Avoid Glare



*Light Projected Against Direction of Traffic*

## Advantages:

- Uniform distribution of light
- Effective in smoke or fog
- Silhouette effect

## Disadvantages:

- Higher installation and maintenance cost
- Possible glare.

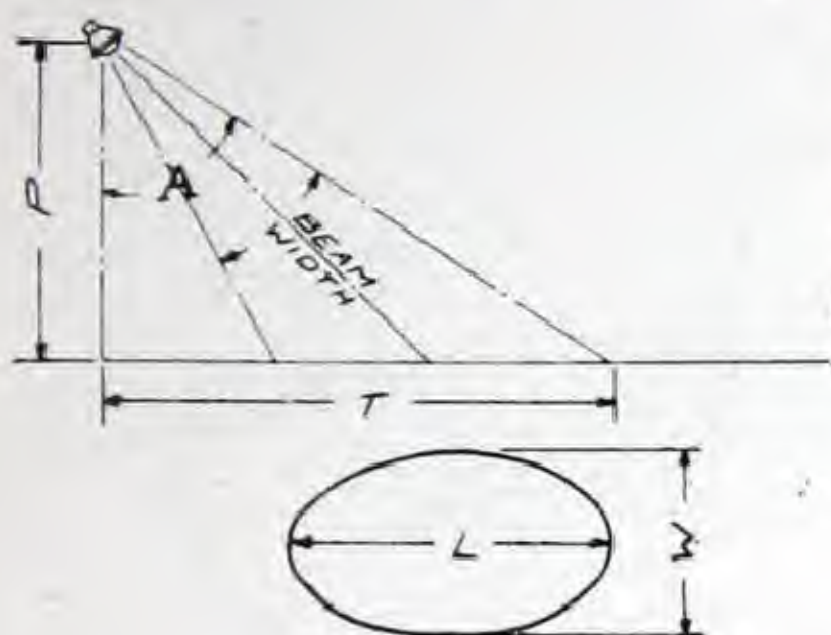
Another variation of the distributed system is that in which the light is projected diagonally across the tracks against the direction

TABLE V  
ILLUMINATING EFFICIENCY OF L-22  
PROJECTOR

Approx. Watts. Per Sq. Ft.	Approx. Average Ft.-cd.
0.0056	0.05
0.011	0.10
0.017	0.15
0.022	0.20
0.028	0.25

TABLE VI

FOOT-CANDLE INTENSITIES BASED ON ONE PROJECTOR ONLY USING A 1000 WAT  
MAZDA C MULTIPLE LAMP  
PROJECTOR WITH CLEAR DOOR GIVES 8825 BEAM LUMENS, 24° BEAM  
PROJECTOR WITH STIPPLED DOOR GIVES 8950 BEAM LUMENS 32° BEAM  
(FIGURES ARE CLOSE APPROXIMATIONS ONLY)



## CLEAR GLASS DOOR

HEIGHT P	70 FT					80 FT					90 FT					100 FT					120 FT				
DISTANCE T	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC
200	70°43'	126'	61'	6040	1.46	68°12'	122'	64'	6190	1.43	65°46'	120'	68'	6350	1.39	63°26'	118'	71'	6550	1.35	59°2'	116'	77'	7000	1.26
400	80°5'	236'	94'	21800	0.41	78°41'	228'	99'	22280	0.40	77°19'	219'	103'	22665	0.39	75°50'	212'	108'	23000	0.38	73°18'	206'	115'	23580	0.38
600	83°21'	402'	120'	45320	0.20	82°23'	470'	126'	46650	0.19	81°28'	453'	133'	47760	0.19	80°32'	449'	138'	48670	0.18	78°41'	431'	148'	50125	0.18
800	85°	674'	142'	74925	0.12	84°7'	660'	150'	77620	0.11	83°35'	647'	157'	79900	0.11	82°53'	634'	164'	81825	0.11	81°28'	612'	177'	84910	0.10
1000	86°	860'	161'	103640	0.08	85°26'	853'	170'	114120	0.08	84°51'	839'	173'	117978	0.08	84°17'	825'	181'	121270	0.07	83°9'	799'	202'	126690	0.07
2000	88°	1337'	235'	342500	0.03	87°43'	1338'	250'	360000	0.02	87°23'	1320'	264'	377500	0.02	87°5'	1303'	277'	391000	0.02	86°34'	1269'	304'	421000	0.02

## LIGHT STIPPLED GLASS DOOR

100	55°	70'	53'	2935	3.05	51°20'	72'	57'	3250	2.76	48°9'	74'	62'	3605	2.48	45°	77'	66'	4000	2.24	39°38'	84'	76'	4970	1.80
200	70°43'	144'	76'	8575	1.04	68°12'	141'	81'	8960	1.00	65°46'	140'	85'	9300	0.96	63°26'	139'	89'	9750	0.92	59°2'	139'	98'	10650	0.84
300	76°32'	230'	96'	17350	0.52	75°4'	225'	102'	17980	0.50	73°18'	221'	107'	18500	0.48	71°34'	217'	112'	19050	0.47	68°12'	212'	121'	20150	0.45
400	80°5'	322'	114'	28800	0.31	78°42'	315'	120'	29800	0.30	77°19'	309'	126'	30650	0.29	75°50'	304'	132'	31400	0.29	73°18'	295'	142'	33000	0.27
500	82°2'	417'	129'	42300	0.21	80°35'	408'	137'	43700	0.20	79°48'	401'	144'	45450	0.20	78°41'	393'	150'	46250	0.19	76°30'	382'	162'	48700	0.18
1000	86°	904'	191'	134850	0.07	85°26'	892'	202'	141800	0.06	84°51'	881'	213'	147650	0.06	84°17'	871'	225'	152800	0.06	83°9'	851'	242'	161700	0.06

of traffic. The projectors, singly, or in pairs, are as a rule mounted on 75-ft. poles or towers, spaced from 200 to 500 ft. apart. This system gives the silhouette effect and the effect of specular reflection from the rails, and also tends to provide uniform illumination throughout the yard.

Whatever system be used, the proper mounting height for the projectors is a most important matter. The greater mounting heights are preferable in order to minimize

as much as possible the dangerous glare effects, to give a more uniform distribution of light, and to eliminate objectionable shadows. Towers 75 ft. high above the rails should be considered the minimum projector mounting height. Towers as high as 120 ft. are in use, and many of 90 ft. or more have been installed.

The projection efficiency of the unit is another important consideration. The suitability of the unit in this respect is measured



surface is dark. What type of floodlighting unit should be used? What is the intensity and the number of units required?

In solving this problem the three controlling conditions are:

(1) The floodlights are to be located 130 feet from the illuminated surface.

The units are to be installed 250 ft. from the illuminated area, there being no other source of light. The set of 250-ft. working distance readings in Table I is reproduced in Table III and shows that the L-1 beam will cover an area of 1820 sq. ft. with approximately fifty times the intensity of moonlight.

TABLE II

BUILDING SURFACES	CHARACTER OF SURROUNDINGS		
	WHITE WAY	RESIDENCES	PARKS
DARK COLORED BLDG IE, SURFACES OF RED BRICK, CLINKER BRICK, BROWN STONE ETC	20 F.C.	15 F.C.	10 F.C.
MEDIUM COLORED BLDG IE, SURFACES OF CONCRETE, GRANITE ETC	15 F.C.	10 F.C.	5 F.C.
LIGHT COLORED BLDG IE, SURFACES OF GLAZED TERRA COTTA, MARBLE ETC.	10 F.C.	5 F.C.	3 F.C.

(2) The object to be floodlighted is in a whiteway section.

(3) The surface to be illuminated has a dark finish.

Table I shows that all the projectors, except the L-3 and L-20 can be used up to a working distance of about 130 feet when equipped with clear-glass doors.

Table II shows that the intensity required for dark surfaces in white-way sections is 20 ft-cd. Assume that the L-15 projector in Table I is selected from which can be determined the number of units necessary to illuminate the area to an intensity of 20 ft-cd. Follow the vertical line from 2000 sq. ft. until it crosses the 20 ft-cd. curve; then by following the horizontal line to the left it will be found that four floodlights should be used. Care should be taken of course to provide sufficient overlapping of the beams to insure even illumination over

It should be remembered that the average foot-candle intensities given in Table I indicate values produced by one unit alone. To increase these intensities, additional units must be used.

TABLE III

	FORM L-1	FORM L-9	FORM L-11	FORM L-15	FORM L-22
BEAM SPREAD, DEG.	11°	12°	15°	31°X39°	19°X25°
BEAM DIAMETER, FT.	48	52.0	66.0	140X177	84X111
BEAM AREA, SQ. FT.	1820	2165	3400	19360	7280
AVERAGE FOOT CANDLES	1.30	1.60	0.44	0.38	1.20

For the various floodlighting units, Table IV gives the lamp wattages, lamp lumens, total lumens, and beam lumens for both clear-glass and stippled-glass doors. It will be further observed that a formula is given at the bottom for determining the number of projectors.

TABLE IV

CLEAR GLASS DOOR										STIPPLED GLASS DOOR									
FORM	PHOTO CURVE	WATTS	LAMP BULB	SERVICE REFLECTOR	LAMP LUMENS	TOTAL LUMENS	BEAM LUMENS	BEAM WIDTH		FORM	PHOTO CURVE	WATTS	LAMP BULB	SERVICE REFLECTOR	LAMP LUMENS	TOTAL LUMENS	BEAM LUMENS	BEAM WIDTH	
L-1	C-61137	500	G-40	FLOODLIGHTING	METAL	8150	5000	2420	11"	L-1	C-61249	500	G-40	FLOODLIGHTING	METAL	8150	4890	2800	48"
L-9	H-130841	500	G-40	FLOODLIGHTING	GLASS	8150	6100	3405	12"	L-9	H-130842	500	G-40	FLOODLIGHTING	GLASS	8150	5780	3840	50"
L-11	C-61242	250	G-30	FLOODLIGHTING	GLASS	3500	2385	1500	15"	L-11	H-132853	250	G-30	FLOODLIGHTING	GLASS	3500	2330	1610	34"
L-20	H-107613	200	PS-30	GENERAL	GLASS	3200	2075	1360	32"	L-20	H-132857	200	PS-30	GENERAL	GLASS	3200	2060	1420	46"
L-3	C-61148	500	G-40	FLOODLIGHTING	GLASS	8150	4950	3270	50"	L-3	C-61149	500	G-40	FLOODLIGHTING	GLASS	8150	4680	4320	90"
L-15	H-132851	1000	PS-52	GENERAL	GLASS	21000	13300	7400	31" X 39"	L-15	H-132852	1000	PS-52	GENERAL	GLASS	21000			
L-22	H-132789	1000	PS-52	GENERAL	GLASS	21000	14450	8960	19" X 25"	L-22	H-132790	1000	PS-52	GENERAL	GLASS	21000	13650	8720	26" X 31"

\* LIGHTLY STIPPLED GLASS DOOR

$$\text{NUMBER OF PROJECTORS} = \frac{\text{AREA OF BLDG FACADE X F.C. REQUIRED}}{\text{BEAM LUMENS OF ONE PROJECTOR}}$$

the entire surface. This example will adequately illustrate all high-intensity floodlighting problems.

Table I also includes data of diameters, areas of the beams and foot-candle intensity of each unit with clear-glass and with stippled-glass doors. A typical problem making use of this information will be given. An area of about 1800 sq. ft. is to be illuminated.

### Lighting Railroad Yards

A few remarks applying to railroad yard lighting by L-22 floodlighting projectors, which are designed for this class of service, may be of interest. Fig. 5 and 6 show two views of this unit. Fig. 7 shows a group of these units mounted on a 75-ft. tower. The lamp usually employed is of the 1000-watt "base up" burning type. The following



are some of the advantages of floodlighting railroad yards:

(1) Increased speed of handling cars at night.

(2) Fewer cars damaged by rough handling and by collision, resulting in a reduction of damage claims, fewer delays in delivery of goods, and decreased loss of car service.



Front View



Rear View

Fig. 5 and 6. Two Views of Form L-22 Floodlight Projector.

(3) Lower losses due to pilfering, owing to a well-lighted yard which enables more effective policing.

(4) Improved and safer working conditions for yard employees.

It is generally conceded that floodlighting is the most economical and effective method of lighting such areas. Several variations in the installation layout for floodlighting

projectors in this service may be observed by referring to the sketches in Fig. 8, 9, and 10.

The units may be installed on towers 70 to 90 ft. high, Fig. 7 showing the group method of arrangement with one-way projection of light.

The following are believed to be some of the advantages derived from the various methods employed, for the different classes of railroad yards.



Fig. 7. Group of Floodlight Projectors for Railroad Yard Service Mounted on 75-foot Tower

### Group System

#### *Two-way Projection of Light*

##### Advantages:

Economical to install and maintain  
Silhouette effect

##### Disadvantages:

Non-uniform distribution of light  
Inefficient in smoke or fog  
Danger from glare.



### One-way Projection of Light

#### Advantages:

- Economical to install and maintain
- No glare

#### Disadvantages:

- No silhouette effect
- Non-uniform distribution of light
- Inefficient in smoke or fog

### Distributed System

#### Light Projected in the Direction of Traffic

#### Advantages:

- Uniform distribution of light
- Effective in smoke or fog
- No glare

#### Disadvantages:

- Higher installation and maintenance cost

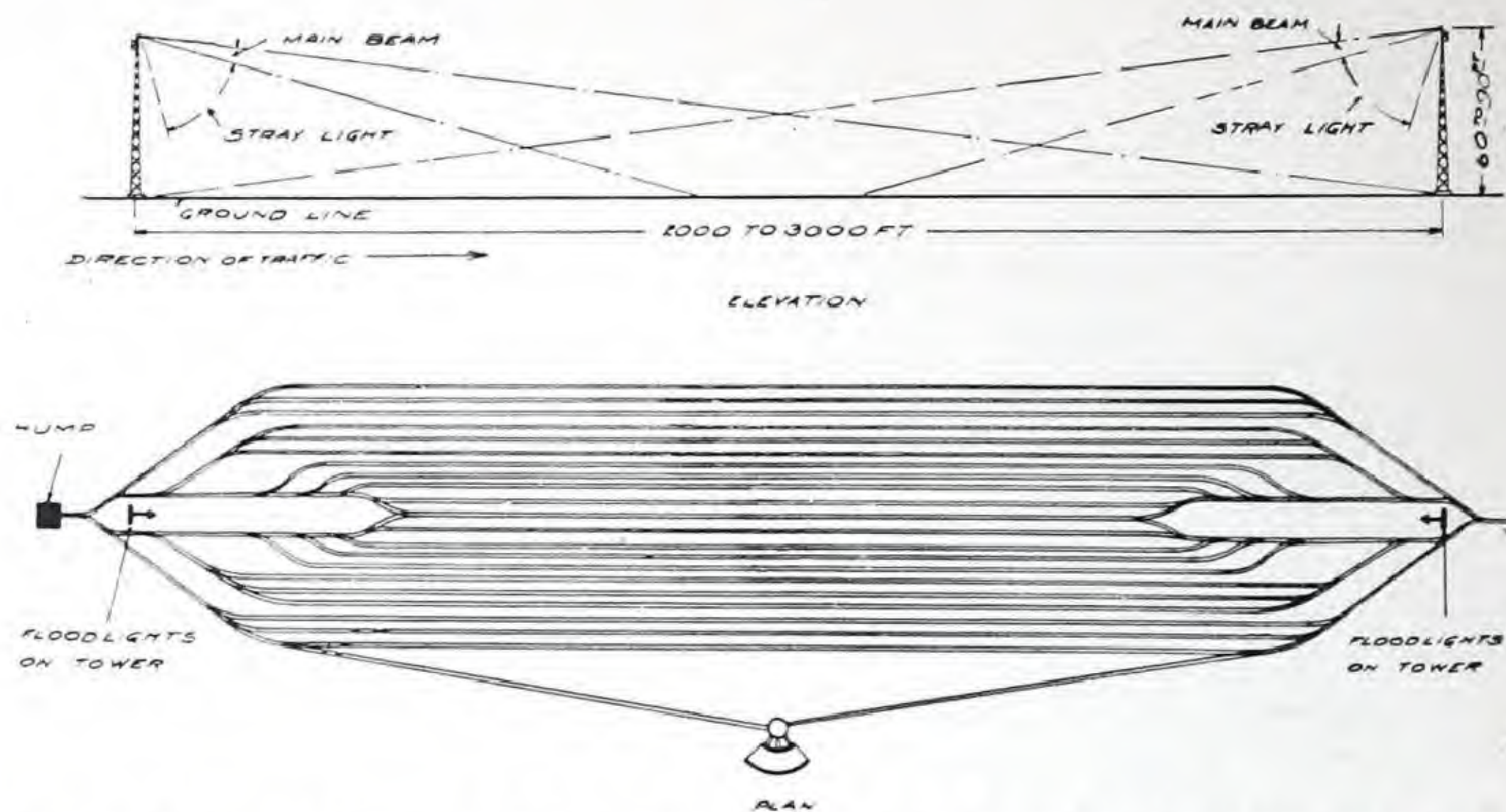


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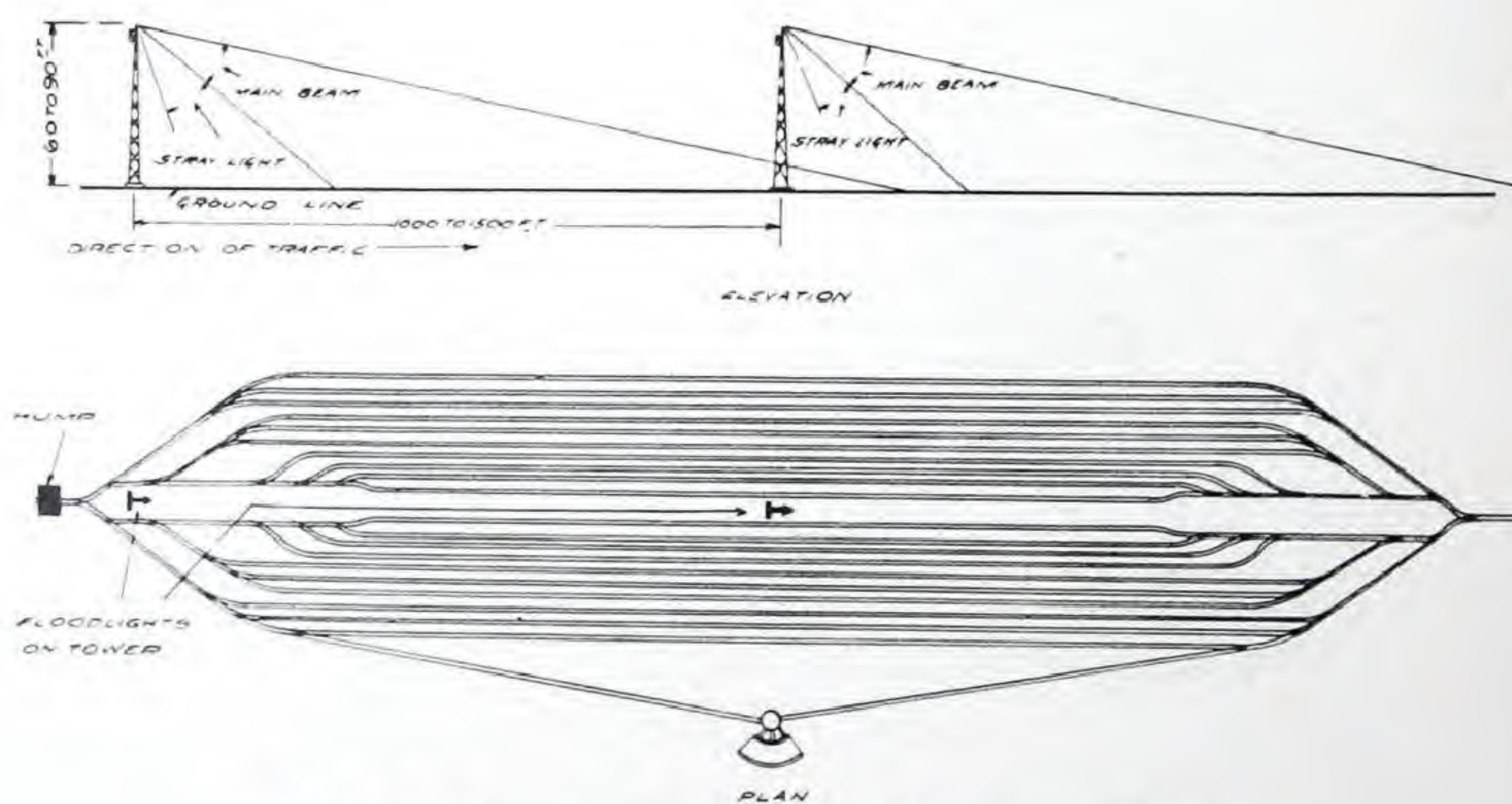


Fig. 9. An Alternative Arrangement to That Shown in Fig. 8



Fig. 10. Low Power Floodlighting with Close Spacing to Avoid Glare



*Light Projected Against Direction of Traffic*

Advantages:

- Uniform distribution of light
- Effective in smoke or fog
- Silhouette effect

Disadvantages:

- Higher installation and maintenance cost
- Possible glare.

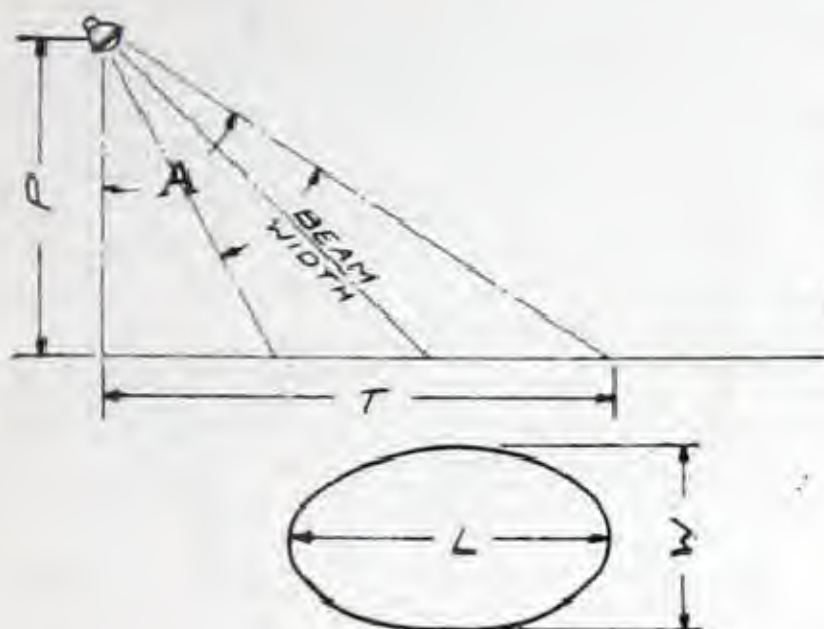
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TABLE V  
ILLUMINATING EFFICIENCY OF L-22 PROJECTOR

Approx. Watts. Per Sq. Ft.	Approx. Average Ft.-cd.
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TABLE VI

FOOT-CANDLE INTENSITIES BASED ON ONE PROJECTOR ONLY USING A 1000 WATT MAZDA C MULTIPLE LAMP  
PROJECTOR WITH CLEAR DOOR GIVES 8825 BEAM LUMENS 24° BEAM  
PROJECTOR WITH STIPPLED DOOR GIVES 8950 BEAM LUMENS 32° BEAM  
(FIGURES ARE CLOSE APPROXIMATIONS ONLY)



CLEAR GLASS DOOR

HEIGHT P	70 FT					80 FT					90 FT					100 FT					120 FT				
DISTANCE T	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC
200	70°43'	126'	61'	6040	1.46	68°12'	122'	64'	6190	1.43	65°46'	120'	68'	6350	1.39	63°26'	118'	71'	6550	1.35	59°2'	116'	77'	7000	1.26
400	80°5'	296'	94'	21800	0.41	78°41'	287'	99'	22280	0.40	77°19'	279'	103'	22665	0.39	75°58'	272'	108'	23000	0.38	73°18'	261'	115'	23580	0.38
600	83°21'	402'	120'	45320	0.20	82°25'	470'	126'	46650	0.19	81°28'	453'	133'	47760	0.19	80°32'	449'	138'	48670	0.18	78°41'	431'	148'	50125	0.18
800	85°	674'	142'	74925	0.12	84°17'	660'	150'	77620	0.11	83°35'	647'	157'	79900	0.11	82°53'	634'	164'	81825	0.11	81°28'	612'	177'	84910	0.10
1000	86°	860'	161'	109640	0.08	85°26'	853'	170'	114120	0.08	84°31'	839'	173'	117978	0.08	84°17'	825'	187'	121270	0.07	83°9'	799'	202'	126690	0.07
2000	88°	1837'	235'	342500	0.03	87°43'	1830'	250'	360000	0.02	87°25'	1820'	264'	377500	0.02	87°8'	1803'	277'	391000	0.02	86°34'	1769'	304'	421000	0.02

LIGHT STIPPLED GLASS DOOR

100	55°	70'	53'	2935	3.05	51°20'	72'	57'	3250	2.76	48°1'	74'	62'	3405	2.48	45°	77'	66'	4000	2.24	39°14'	84'	76'	4970	1.80
200	70°43'	144'	76'	8575	1.04	68°12'	141'	81'	8960	1.00	65°46'	140'	85'	9300	0.96	63°26'	139'	89'	9750	0.92	59°2'	139'	98'	10650	0.84
300	76°52'	230'	96'	17350	0.52	75°4'	225'	102'	17980	0.50	73°18'	221'	107'	18500	0.48	71°34'	217'	112'	19050	0.47	68°12'	212'	121'	20150	0.45
400	80°5'	322'	114'	28800	0.31	78°41'	315'	120'	29800	0.30	77°19'	309'	126'	30650	0.29	75°58'	304'	132'	31400	0.29	73°18'	295'	142'	33000	0.27
500	82°2'	417'	129'	42300	0.21	80°35'	408'	137'	43700	0.20	79°40'	401'	144'	45450	0.20	78°41'	393'	150'	46250	0.19	76°30'	382'	162'	48700	0.18
1000	86°	904'	191'	134850	0.07	85°26'	892'	202'	141800	0.06	84°31'	881'	213'	147650	0.06	84°17'	871'	223'	152800	0.06	83°9'	851'	242'	161700	0.06

of traffic. The projectors, singly, or in pairs, are as a rule mounted on 75-ft. poles or towers, spaced from 200 to 500 ft. apart. This system gives the silhouette effect and the effect of specular reflection from the rails, and also tends to provide uniform illumination throughout the yard.

Whatever system be used, the proper mounting height for the projectors is a most important matter. The greater mounting heights are preferable in order to minimize

as much as possible the dangerous glare effects, to give a more uniform distribution of light, and to eliminate objectionable shadows. Towers 75 ft. high above the rails should be considered the minimum projector mounting height. Towers as high as 120 ft. are in use, and many of 90 ft. or more have been installed.

The projection efficiency of the unit is another important consideration. The suitability of the unit in this respect is measured



by the total lumens delivered, by the beam lumens, and the beam candle-power. The total lumens are the measure of the total flux of light delivered by the projector; the beam lumens indicate the quantity of light flux in the beam; and the candle-power is the measure of the pressure or intensity of the light. The lighting of a railroad yard is the lighting of a large area, therefore considera-

balance of lumens, candle-power, and spread of beam to obtain the maximum efficiency consistent with the other desirable characteristics. Towers and the space to install them in the railroad yard are expensive, and therefore every possible reduction should be made in these respects.

Table V represents modern practice which will meet existing conditions in average



Fig. 11. Various Types of Floodlighting Projectors

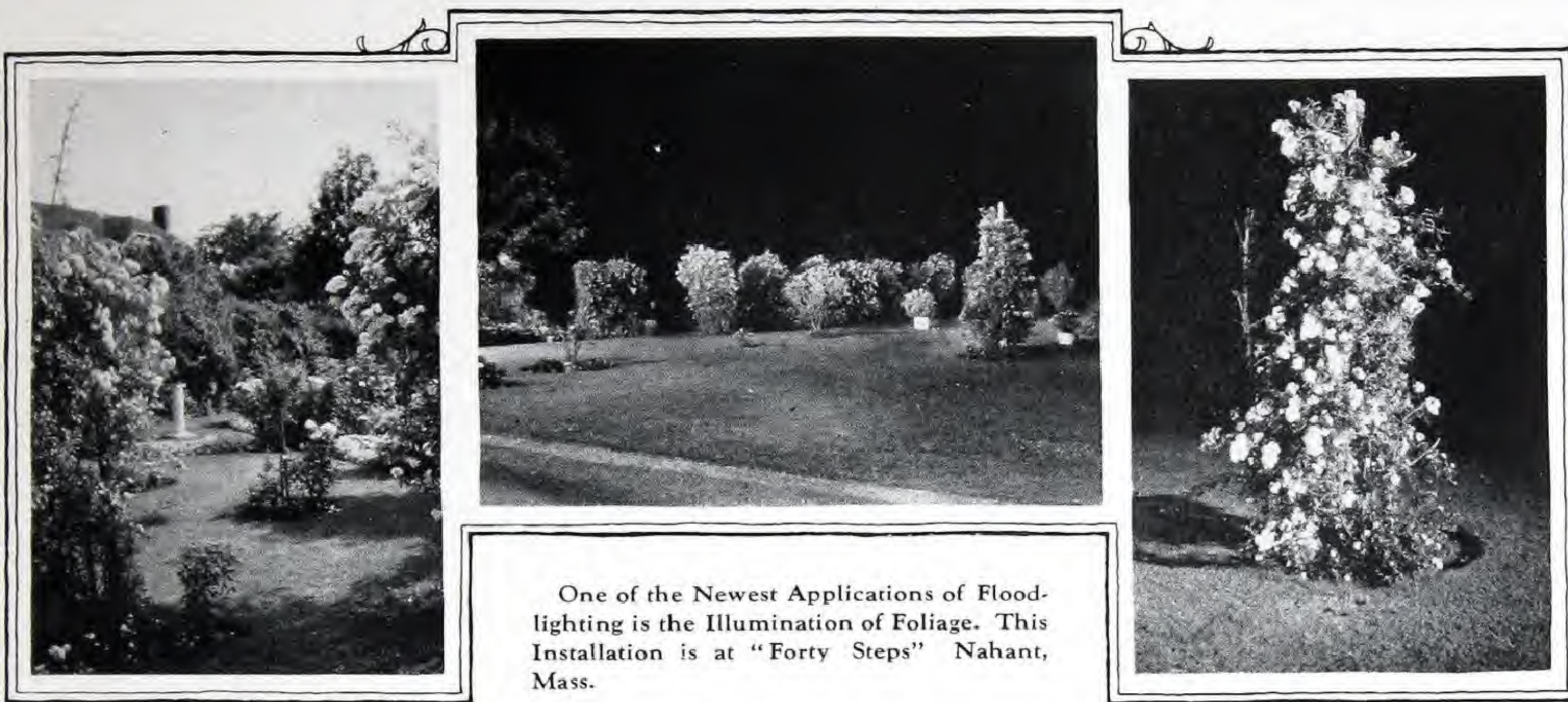
tion must be given to the coverage of the projector; i.e., to the spread of the beam. Obviously a narrow beam of high candle-power is not adapted to this class of service, for while it can be transmitted a great distance it results merely in a spot of light in the yard. It is, therefore, desirable to utilize a spread beam sufficiently great to obtain the coverage found necessary in practice and of sufficient candle-power to provide the desired illumination at distances from the projector corresponding to the usual spacings. In the design of the projector shown in Fig. 5 and 6 careful consideration has been given to the proper

railroad yards, based upon the beam lumen output of the L-22 unit.

Table VI also relates to the L-22 beam and gives the beam lengths, width, area, and beam foot-candles for both clear-glass and stippled-glass doors, together with the tilted angle necessary for the various mounting heights and spacings considered for this field of work.

In Fig. 11 are shown various types of floodlighting projectors that are in use today. By fitting each to the conditions for which it was designed, highly satisfactory lighting for all out-of-door purposes can be obtained.





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